

(43) **Pub. Date:** **Sep. 8, 2016**

Fig. 1

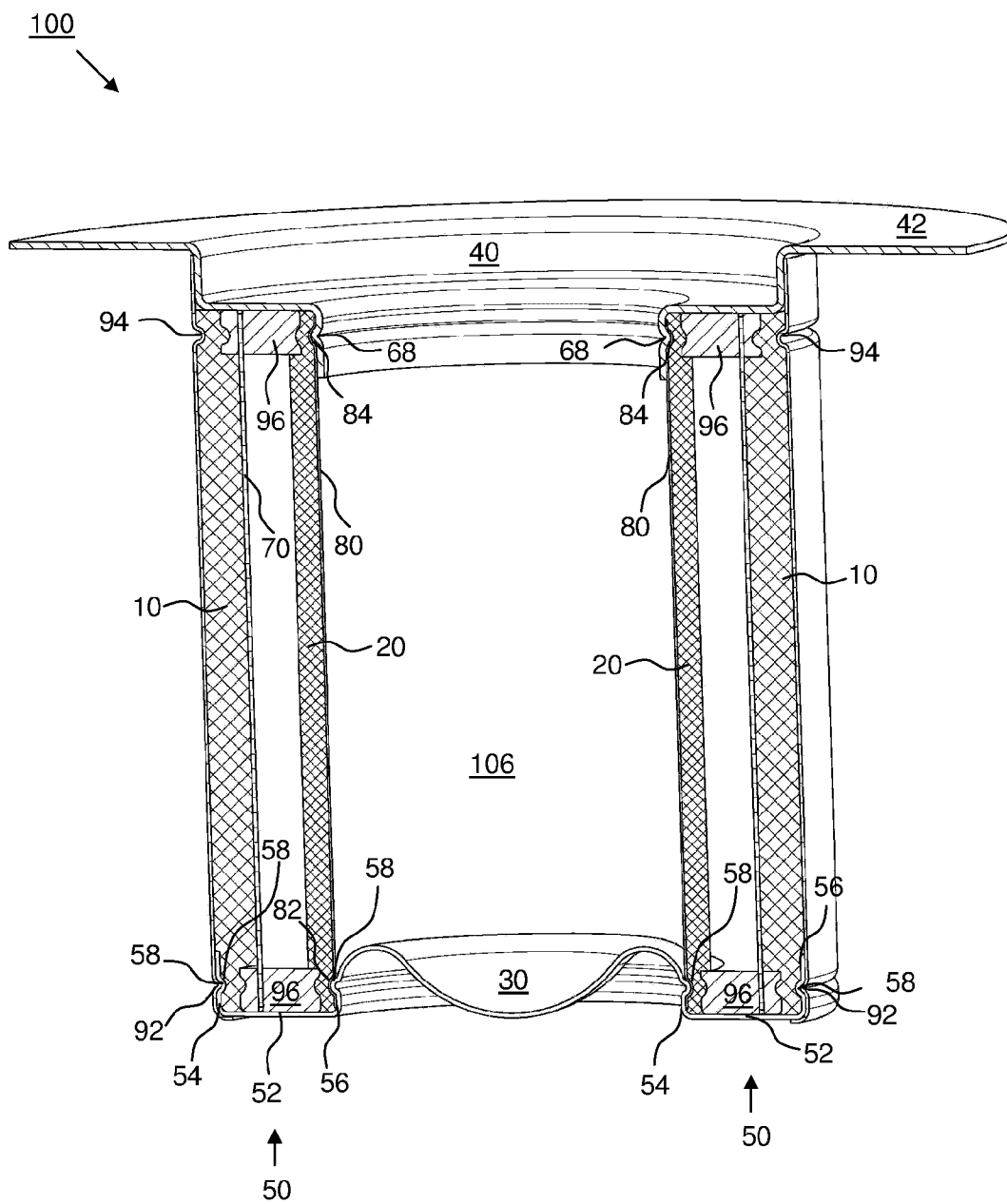


Fig. 2

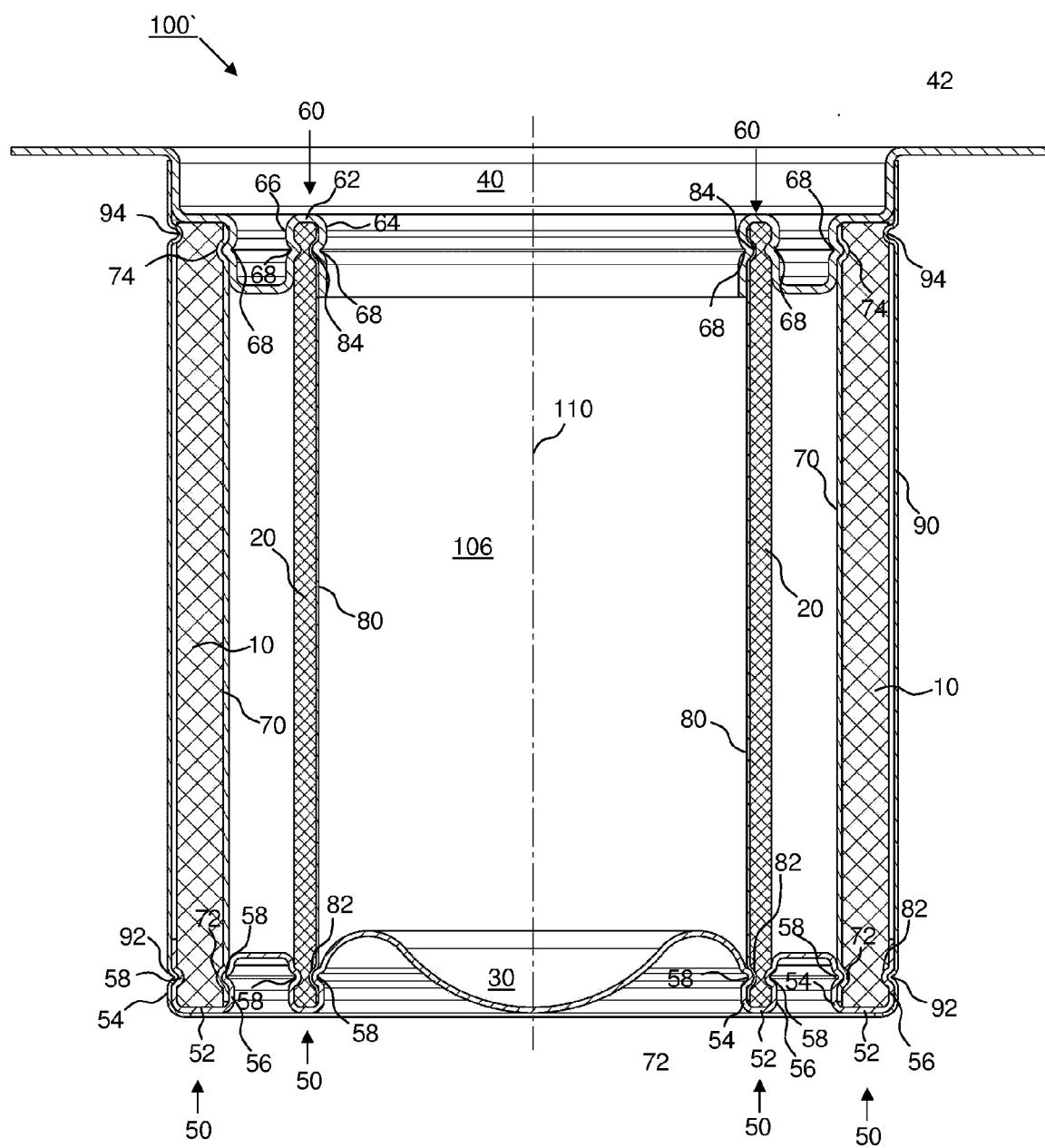


Fig. 3

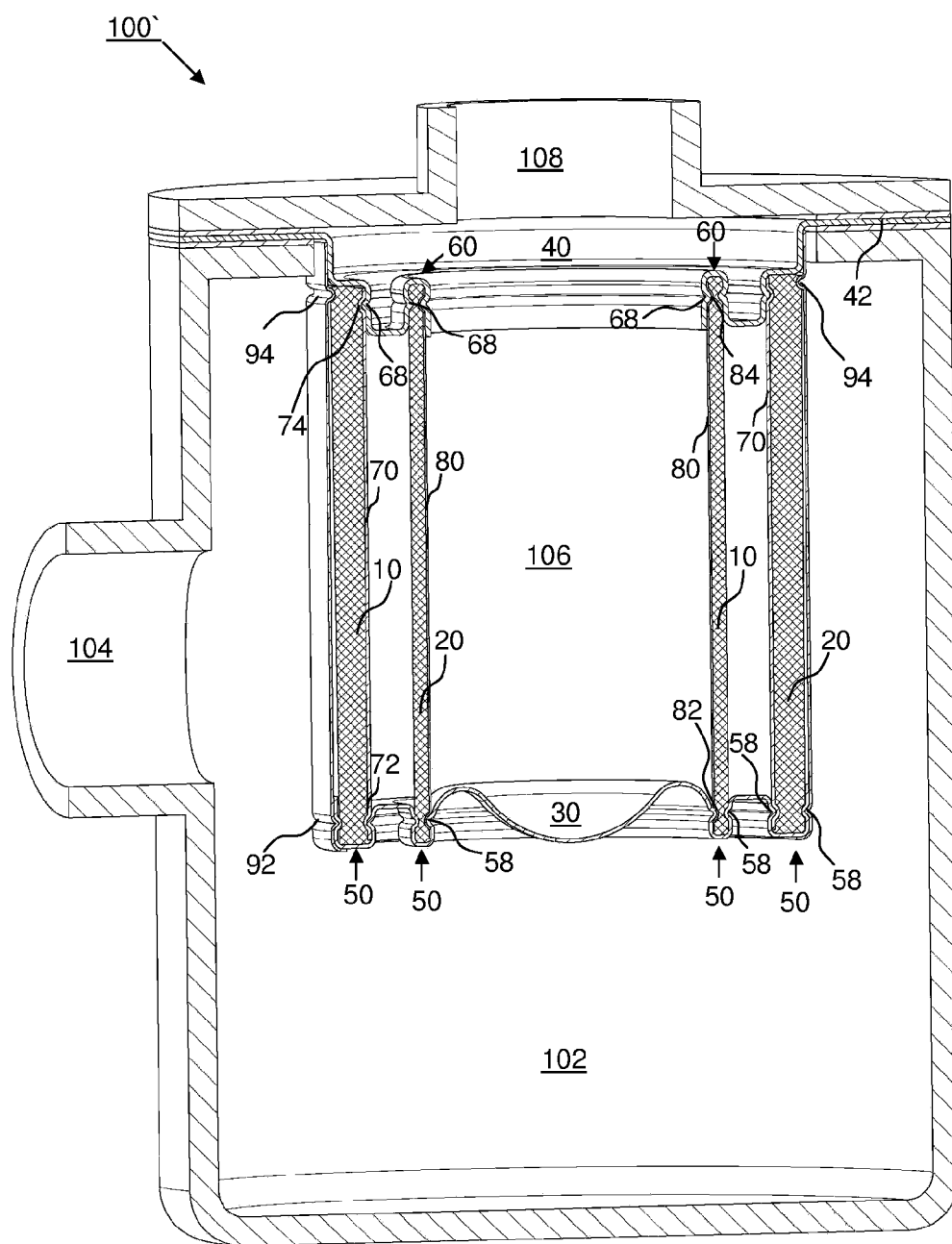


Fig. 4

FILTER INSERT AND METHOD FOR MANUFACTURING A FILTER INSERT

TECHNICAL FIELD

[0001] The invention relates to a filter insert for installation in a housing, in particular a pressure vessel, having

[0002] at least one filter element for separating liquid from an aerosol, in particular oil from aerosol, for example for the de-oiling of air, which is formed in a substantially hollow cylindrical manner, for example at least one cylindrically wound separator element, and

[0003] at least one covering element, in particular at least one end plate, designed to cover an axial end region of the filter element, in particular a region of an end face of the filter element, wherein the covering element or at least one covering element is formed from sheet metal and is connected with the filter element in a purely mechanical manner, in particular free from adhesives and sealants.

[0004] The present invention further relates to a method for manufacturing a filter insert for installation in a housing, in particular a pressure vessel, wherein

[0005] at least one hollow cylindrical filter element for separating liquid from an aerosol, in particular oil from aerosol, for example for the de-oiling of air, with

[0006] at least one covering element for covering an axial end region of the filter element which is formed from sheet metal and connected in a manner in particular free from adhesives and sealants.

BACKGROUND OF THE INVENTION

[0007] A filter is known from WO 2013 024105 A1 for the de-oiling of air originating from an air compressor or a vacuum pump. In this filter, a sealing connection between the filter elements and a U-shaped groove of a covering element of the filter is produced through the use of an adhesive or sealant. However, the use of adhesives for fixing the filter element is expensive and additionally problematic due to the partial uncertainty of the chemical and thermal stability.

[0008] A prototypical filter insert is known from WO 96 28238 A1. In this filter insert, a filter element wound on a support tube is connected by means of a flange connection or flanging with a mounting flange of the filter housing. A flange is understood here as a connection which is produced through right-angle bending of an edge of a round or oval metal sheet. The flange connection of WO 96 28238 A1 enables the omission of an adhesion of the filter element on the end face of the filter insert. For producing this flange connection, a flange ring is arranged in the end region of the air de-oiling element. This flange ring is a separate element which is not integrated in the end face covering element of the filter insert. The flange ring itself is not flanged, but rather serves as a counter support for a bead introduced in the mounting flange and the support tube.

SUMMARY OF THE INVENTION

[0009] The object of the invention is to develop a filter insert of the aforementioned type and a method of the aforementioned type such that the filter insert is designed in a compact manner and is inexpensive and easy to manufacture.

[0010] The present invention is based on the principle of clamping the filter element on the covering element solely by means of deformation of the covering element. The deforma-

tion of the covering element is preferably performed using the technique of beading or flanging. Here, it is particularly advantageous that the mechanical connection between the covering element and the filter element takes place substantially and in particular completely by means of a form lock which prevents a disengagement in the axial direction.

[0011] In an advantageous embodiment of the present invention, a sealing, in particular gas sealing, connection between the filter element or at least one of the filter elements and the covering element or at least one of the covering elements is produced via the deformation.

[0012] The covering element may be at least one end plate formed from metal, wherein the end plate covers the end face of the filter element and at least one region of the shell surface of the filter element, and is connected with the filter element such that the pure side of the filter element is separated from the environment in a gas-tight manner.

[0013] The mechanical connection between the covering element and the filter element is formed purely through the structure of the covering element produced by the deforming or reforming of the covering element, wherein this structure is designed to clamp the filter element to the covering element in a manner secure from slipping.

[0014] The structure advantageously has at least one and preferably two covering element beads, which form a flange which is integrated into the covering element. This may extend in partial sections or completely around the covering element.

[0015] In an advantageous embodiment of the present invention, the at least one filter element is received in a U-shaped groove in the covering element, wherein in order to connect the covering element with the filter element, the two sides of this U-shaped groove have at least one covering element bead and the covering element beads are designed to hold the filter element received in the groove in a manner such that it cannot slip.

[0016] In order to achieve an optimum clamping effect, the covering element beads are advantageously arranged on mutually opposing regions of the sides of the groove.

[0017] A particularly advantageous embodiment of the present invention distinguishes itself from the prior art, in particular with respect to WO 96 28238 A1, in that a flange with two opposite beads for connecting the covering element with the filter element is integrated directly in the covering element, which forms a U-shape for this purpose at at least one location.

[0018] The covering element beads are trough-shaped depressions in the covering element and may be pressed into the covering element, for example, by machine with a beading machine using two beading rollers. Alternatively, the covering element beads may also be produced manually using a beading hammer.

[0019] In order to receive the entire axial end region of at least one of the filter elements, the groove is preferably formed substantially annularly when viewed in a section transverse to the longitudinal axis of the filter insert. In order to achieve the most uniform clamping action possible, the covering element beads advantageously encircle the entire circumference of the side of the groove.

[0020] The filter insert may have, for example, two covering elements or end plates which are each arranged on opposite axial end regions of the filter element. In the case of two covering elements, a structure with covering element beads

formed by means of deforming or reforming each covering element is advantageously integrated into both covering elements.

[0021] The filter insert may have at least two filter elements, in particular at least one primary filter and at least one secondary filter. Here, for example, the axial end regions of at least two filter elements may be received in the groove, wherein each of the filter elements can be spaced apart from one another by means of at least one spacer, for example at least one insertion element. Thus, for example, only one structure may be integrated into the covering element, so that, for example, the covering element forms a U-shape at only one location.

[0022] Alternatively, the at least one covering element may have a U-shaped groove for each of the filter elements. In this embodiment, the at least one covering element forms a U-shape at at least two locations.

[0023] The at least one U-shaped groove respectively directly or indirectly, for example with the interposition of at least one support tube designed to support the filter element, abuts the outer shell surface, the inner shell surface and the upper surface of the hollow cylindrical filter element associated therewith.

[0024] In a particularly advantageous embodiment of the present invention, the following elements of the filter insert, specifically

- [0025]** the at least one filter element,
- [0026]** the at least one covering element,
- [0027]** optionally at least one axially acting sealing element arranged in the groove,
- [0028]** optionally at least one metal support tube for supporting the filter element and
- [0029]** optionally at least one tube-formed metal protective element, in particular a grid-like, perforated metal support tube, which encloses the outer shell surface of the filter element,

are connected with one another in a purely mechanical manner, wherein the connection is formed solely by a deformation of the metal elements of the filter element, in particular the covering element and optionally the support tube and/or the protective element.

[0030] In the manufacture of the filter insert, the filter element is first advantageously inserted in a U-shaped groove of the covering element and, in order to connect the filter element inserted into the groove of the covering element with the covering element, pressed with the covering element into the two sides of the groove with at least one covering element bead such that the covering element bead clamps the filter element in a manner free from slipping.

[0031] The filter insert may including two covering elements, wherein in the production of the filter insert, both covering elements are arranged on mutually opposing axial end regions of the filter element and the filter element is respectively connected on each of its axial end regions with one of the covering elements. In the present invention, both covering elements can be simultaneously connected to the filter element. In contrast thereto, in the prior art, in which the filter element is connected with the covering elements by means of adhesion, first a first axial end region of the filter insert is adhered to the covering element associated therewith, then must be waited until the adhesive is dry and only then can the opposite axial end region of the filter insert be adhered to the covering element associated therewith.

[0032] Possible applications of the invention can be found in all types of separators which are based on a wound separating medium. Currently these are, for example, oil separators with and without flanges as well as oil separation boxes, so-called spin-ons, as well as oil separators as are used for crankcase ventilation.

[0033] The term filter element is used in the context of this application to mean "filter body," and is to be understood as the part of an interchangeable filter insert arranged, for example, in a pressure vessel, which produces the separation effect. For the present invention, the filter element is advantageously designed as a filter wrap, i.e. at least one filter medium which is wound a plurality of times about an in particular perforated support tube, in particular non-woven filter material.

BRIEF DESCRIPTION OF THE DRAWINGS

[0034] As already discussed above, there are various possibilities to form and develop the present invention in an advantageous manner. Reference is made to this end to the dependent claims of claim 1 and claim 10, and in addition further embodiments, features and advantages of the present invention are explained in more detail below, with reference to the exemplary embodiments illustrated by FIGS. 1 to 4, inter alia.

[0035] FIG. 1 shows a longitudinal section of a first embodiment of a filter insert according to the present invention, which has been manufactured according to the method according to the present invention;

[0036] FIG. 2 shows an isometric longitudinal representation of the filter insert of FIG. 1 without the bead rollers of the beading machine;

[0037] FIG. 3 shows a longitudinal section of a second embodiment of a filter insert according to the present invention, which has been manufactured according to the method according to the present invention;

[0038] FIG. 4 shows an isometric longitudinal representation of the filter insert of FIG. 3, wherein this filter insert is installed in a housing.

[0039] Identical or similar embodiments, elements or features are provided in FIGS. 1 to 4 with identical reference characters.

DETAILED DESCRIPTION OF THE INVENTION

[0040] To avoid unnecessary repetition, the following explanations with respect to embodiments, features and advantages of the present invention relate (insofar as not otherwise indicated) to both the filter insert 100 shown in FIGS. 1 and 2 as well as the filter insert 100' shown in FIGS. 3 and 4.

[0041] FIG. 1 shows a first embodiment of a filter insert 100 during the manufacture thereof. In the manufacturing of this filter insert 100, two hollow cylindrical filter elements 10, 20 for filtering liquid from an aerosol, namely a primary filter element 10 and a secondary filter element 20, are connected in a purely mechanical manner with covering elements 30, 40 arranged on the respective end faces of the filter elements 10, 20, namely with a first end plate 30 and a second end plate 40. The second end plate 40 is a lid designed to cover the filter insert 100. The connection between the first end plate 30 and the filter elements 10, 20 is provided solely through a deforming or reforming of the first end plate 30. Here, the end plate

30 is deformed or reformed in such a way that the filter elements **10**, **20** are clamped on the end plate **30** in a manner secure from slipping.

[0042] The flow direction of the aerosol to be filtered is marked in FIG. 1 by means of arrows.

[0043] The end plate **30** has a U-shaped groove **50** for receiving the end face of the filter element **10**, **20**. This U-shaped groove **50** surrounds the entire annular axial end region of the hollow cylindrical filter element **10**, **20**.

[0044] In order to achieve an optimal filtering effect, the filter elements **10**, **20** are separated from one another by at least one spacer **96**, for example by at least one insertion element.

[0045] To establish the connection between the filter elements **10**, **20** and the first end plate **30**, at least one covering element bead **58** is pressed on the two sides of the groove **50** by means of bead rollers **200** of a beading machine such that the covering element beads **58** clamp the filter elements **10**, **20** in the groove **50** in a manner secure from slipping.

[0046] FIGS. 3 and 4 show a second exemplary embodiment of a filter insert **100'** of the present invention. In this second embodiment, the end plate **30** has two U-shaped grooves **50**, **60**. Here, one of the respective filter elements **10**, **20** is inserted in the grooves **50**, **60**. In this embodiment, both the first covering element **30** and the second covering element **40**, thus both the first end plate **30** and the cover **40**, are connected with the filter elements **10**, **20** solely through a deforming or reforming of the covering elements **30**, **40**.

[0047] In detail, for example, in a first process step (i), the filter elements **10**, **20** are respectively wound about a metal support tube **70**, **80** designed to support the filter elements **10**, **20**. So that the flow of the aerosol flowing through the filter insert is not hindered, the support tubes advantageously have perforations or holes.

[0048] In a subsequent process step (ii), the filter elements **10**, **20** with the support tubes **70**, **80** are inserted into the at least one groove **60** of the cover **40** of the filter insert **100**. The at least one groove **60** of the cover **40** of the filter insert **100** is thus advantageously formed to also receive at least one of the support tubes **70**, **80**.

[0049] In a subsequent process step (iii), the first end plate **30** is placed on the axial end region of the filter elements **10**, **20**, wherein this axial end region lies opposite the cover **40** or the axial end region **30** of the filter elements **10**, **20** inserted in the groove **60**. The at least one groove **50** of the first end plate is thus advantageously formed to receive an axial end region of at least one of the filter elements **10**, **20** and an axial end region of at least one of the support tubes **70**, **80**.

[0050] In a subsequent process step (iv), the two end plates **30**, **40**, i.e. the first end plate **30** and the cover **40**, are connected with the filter elements **10**, **20**, for example simultaneously, through the pressing of the covering element beads **58**, **68** by means of the technique of beading or flanging.

[0051] In the second embodiment of the filter insert **100'** shown in FIGS. 3 and 4, support tube beads **72**, **74**, **82**, **84** are pressed both into the support tube **70** arranged in the first groove **50** as well as into the support tube **80** arranged in the second groove **50**. In the first embodiment of a filter insert **100** shown in FIGS. 1 and 2, in which both support tubes are arranged in the same groove **50**, support tube beads **82**, **84** are pressed only into the support tube **80** arranged on the second filter element **20**. The support tube beads **72**, **74** and **82**, **84** are designed to interact with the covering element beads **58** and **68** of the groove **50** or **60** such that the filter element **10**, **20**

clamps in the groove **50** or **60**. As shown in FIG. 1, the support tube bead **72**, **82** can directly abut the covering element bead **58**, **68** of the end plate **30**, **40** associated therewith, in particular such that the beads interlock in a form-locking manner.

[0052] For easier handling of the filter element **100** or **100'**, as well as for the protection of a shell surface of the first filter element **10** opposite an inner cavity **106** of the filter insert **100** designed for discharging the purified gas or for supplying the aerosol to be purified, a tube-shaped metal protective element **90**, in particular a grid-like perforated metal protective tube, may be arranged about the shell surface of the first filter element **10** and clamped on the shell surface of the first filter element **10** by means of the technique of beading or flanging. As shown in FIGS. 1 to 4, the protective element **90** may thus include at least one in particular circumferential protective element bead **92**, **94**, wherein the protective element bead **92**, **94** is designed to clamp the support element **90** on the outermost shell surface of the filter elements **10**, **20** in a manner secure from slipping.

[0053] In the first exemplary embodiment of a filter insert **100** shown in FIGS. 1 and 2, a protective element bead **94** arranged in the region of the cover **40** interacts with an opposite covering element bead **68** such that the two filter elements **10**, **20** are clamped between this protective element bead **94** and the opposite covering element bead **68**.

[0054] In the second exemplary embodiment of a filter insert **100'** shown in FIGS. 3 and 4, a protective element bead **94** arranged in the region of the cover **40** interacts with an opposite covering element bead **68** such that the first filter element **10** is clamped between this protective element bead **94** and the opposite covering element bead **68**.

[0055] For sealing the connection between the filter elements **10**, **20** and the cover **40**, at least one axially acting sealing element can be applied, in particular sprayed or laid, onto the bottom of the U-shaped groove **60** of the cover **40**, for example after clamping of the metal support element **90** to the outermost shell surface of the filter elements **10**, **20**.

[0056] In short, an advantageous embodiment of the method of the present invention includes the following process steps:

[0057] (i) Winding the filter material of the filter elements **10**, **20**, in particular a non-woven fabric, onto metal support tubes **70**, **80**;

[0058] (ii) Inserting the support tubes **70**, **80** into the metal cover **40**, in particular in the U-shaped groove **60** of the metal cover **40**;

[0059] (iii) Placing the metal end plate **30** with its at least one U-shaped groove **50** onto the end face of the filter element **100** or **100'** which is opposite the cover **40**;

[0060] (iv) Connecting the non-woven fabric winding **10**, **20** with the end plate **30** by means of beading and simultaneously connecting the non-woven fabric winding **10**, **20** with the cover **40** by means of beading;

[0061] (v) Optionally arranging the metal protective element or protective screen **90** about the outermost non-woven fabric winding **10**, then beading once again; and

[0062] (vi) Optionally applying a sealing element to the cover **40**.

[0063] In the two embodiments of a filter insert **100**, **100'** shown in FIGS. 1 to 4, all elements of these filter inserts **100**, **100'** including all separating media are connected with one another exclusively mechanically and without the use of adhesives or sealants. All elements of the filter inserts **100**, **100'** are connected with one another by means of at least one

clamping connection, wherein the clamping connection is formed solely by means of a deformation of the metal elements of the filter inserts **100**, **100'**. The deformation of the metal elements takes place by means of the technique of beading or flanging. Here, the covering elements **30**, **40**, the support tubes **70**, **80** and the protective element **90** are beaded or flanged.

REFERENCE CHARACTERS

[0064] **10** filter element, in particular primary filter element
 [0065] **20** additional filter element, in particular secondary filter element
 [0066] **30** covering element, in particular end plate, for covering an axial end region, in particular a front region or covering surface, of the filter element **10**, **20**
 [0067] **40** second or additional covering element, in particular second or additional end plate, for example cover, for covering a further axial end region, in particular an additional front region or additional covering surface, of the filter element **10**, **20**
 [0068] **42** fixing flange for fixing the filter insert **100**, **100'** in the housing **102**
 [0069] **50** in particular U-shaped groove of the covering element **30**
 [0070] **52** bottom of the U-shaped groove **50** of the covering element **30**
 [0071] **54** first side of the U-shaped groove **50** of the covering element **30**
 [0072] **56** second side of the U-shaped groove **50** of the covering element **30**
 [0073] **58** covering element bead, in particular covering element bead gutter-like channel or depression, of the U-shaped groove **50** of the covering element **30**
 [0074] **60** U-shaped groove of the additional covering element **40**
 [0075] **62** bottom of the U-shaped groove **60** of the additional covering element **40**
 [0076] **64** first side of the U-shaped groove **60** of the additional covering element **40**
 [0077] **66** second side of the U-shaped groove **60** of the additional covering element **40**
 [0078] **68** further covering element bead, in particular gutter-like channel or depression, of the U-shaped groove **60** of the additional covering element **40**
 [0079] **70** support tube, in particular central tube, for supporting the filter element **10**
 [0080] **72** support tube bead, in particular first support tube bead, for example gutter-like channel or depression, of the support tube **70**
 [0081] **74** additional support tube bead, for example gutter-like channel or depression, of the support tube **70**
 [0082] **80** additional support tube, in particular additional central tube, for supporting the additional filter element **20**
 [0083] **82** support tube bead, in particular support tube bead, for example gutter-like channel or depression, of the additional support tube **80**
 [0084] **84** additional support tube bead, in particular gutter-like channel or depression, of the additional support tube **80**
 [0085] **90** tube-shaped metal protective element, in particular grid-like perforated metal protective tube
 [0086] **92** protective element bead
 [0087] **94** additional protective element bead
 [0088] **96** spacer, for example insertion element

[0089] **100** filter insert of the first embodiment (see FIGS. 1 and 2)

[0090] **100'** filter insert of the second embodiment (see FIGS. 3 and 4)

[0091] **102** housing, in particular pressure vessel

[0092] **104** central flow opening, in particular inflow opening for the aerosol to be filtered

[0093] **106** inner cavity of the filter insert **100**

[0094] **108** outflow opening for the filtered purified fluid, in particular purified air

[0095] **110** longitudinal axis of the filter insert **100**

[0096] **200** bead rollers of a first beading machine

1. A filter insert for installation in a housing, comprising:
 at least one substantially hollow cylindrical filter element for separating liquid from aerosol; and
 at least one covering element designed to cover an axial end region of the filter element;

wherein at least one of the at least one covering element is formed from at least one metal sheet and connected with the filter element with at least one mechanical connection;

wherein the mechanical connection between the at least one covering element and the filter element is formed solely by a structure of the at least one covering element produced through deforming or reforming the at least one covering element;

wherein the structure of the at least one covering element is configured to clamp the filter element to the at least one covering element.

2. The filter insert according to claim 1, wherein the structure of the at least one covering element has at least one groove which is substantially U-shaped when seen in a section along a longitudinal axis of the filter insert and at least one radial covering element bead, which is arranged on one of two sides of the at least one groove; wherein in a position of use of the filter insert:

the at least one groove receives the axial end region of at least one of the filter elements;

the bottom of the at least one groove abuts directly or indirectly against the axial end region of the filter element received in the groove and the two sides of the at least one groove extend parallel to a shell surface of the filter element received in the at least one groove; and

the at least one covering element bead clamps the filter element received in the at least one groove into the at least one groove in a manner secure from slipping.

3. The filter insert according to claim 2, wherein the structure of the at least one covering element each has a respective covering element bead arranged on each of the two sides of the at least one groove, which covering element bead clamps the filter element received in the at least one groove into the at least one groove in a manner secure from slipping.

4. The filter insert according to claim 3, wherein the covering element beads are arranged on mutually opposite regions of the sides of the at least one groove.

5. The filter insert according to claim 2, wherein when seen in a section transverse to the longitudinal axis of the filter insert, the at least one groove is formed in a substantially annular manner and the covering element bead or covering element beads encircle the entire circumference of the sides of the at least one groove.

6. The filter insert according to claim 2, wherein at least one metal support tube designed to support the filter element;
- wherein the at least one groove is additionally formed to receive the support tube or at least one of several support tubes; and
- wherein the support tube has at least one support tube bead, which is designed to interact with the covering element bead or covering element beads of the at least one groove such that the filter element clamps in the at least one groove, in particular that the support tube bead, directly abuts one of the covering element beads, such that the beads engage with one another in a form locking manner.
7. The filter insert according to claim 2, wherein the axial end regions of at least two filter elements are received in the at least one groove, wherein the respective filter elements are spaced apart from one another at least one spacer configured as at least one insertion element.
8. The filter insert according to claim 2, wherein the filter element is two filter elements: a primary e and a secondary filter;
- wherein the at least one of the covering element is has a U-shaped groove for each of the filter elements; and
- wherein the U-shaped groove directly or indirectly with the interposition of the support tube for supporting the filter element, abut respectively against an outer shell surface, an inner shell surface and a covering surface of the hollow cylindrical filter element associated therewith.
9. The filter insert according to claim 8, wherein at least one tube-shaped metal protective element is configured as a grid-like perforated metal protective tube, which completely surrounds the outer shell surface of the filter element facing away from an inner cavity of the filter insert for discharging the purified gas or for supplying the aerosol to be purified, or an outermost shell surface of the filter element furthest away from the inner cavity;
- wherein the protective element has at least one circumferential protective element bead; and
- wherein the protective element bead is designed to clamp the protective element on the outer shell surface of the filter element or the outermost shell surface of the filter element in a manner secure from slipping.
10. The filter insert according to claim 9, wherein the protective element bead or at least one of the protective element beads is designed to interact with at least one of the covering element beads such that the covering element is clamped in the protective element such that the protective element beads or at least one of the protective element beads abuts directly against one of the covering element beads.

11. A method for manufacturing a filter insert for installation in a housing, wherein
- at least one hollow cylindrical filter element for separating a liquid from an aerosol is connected in a purely mechanical manner with at least one covering element designed to cover an axial end region of the filter element and formed from at least one metal sheet;
- wherein the connection between the covering element and the filter element is provided solely through the deforming or reforming of the covering element;
- wherein the covering element is deformed such that the filter element is clamped on the covering element.
12. The method according to claim 10, wherein the filter element is inserted into at least one U-shaped groove of the covering element; and
- the covering element is connected with the filter element inserted into the groove, in that at least one respective covering element bead is pressed on both sides of the groove such that the covering element beads clamp the filter element in the groove.
13. The method according to claim 12, wherein the filter insert comprises two covering elements, wherein both covering elements are arranged on mutually opposite axial end regions of the filter element;
- the filter element is respectively connected at each of its axial end regions with one of the covering elements; and
- both of the covering elements are simultaneously connected with the filter element by means of a beading technique.
14. The method according to claim 13, wherein the filter element is wound about a metal support tube for supporting the filter element;
- wherein the filter element is inserted with the support tube into the groove of the second covering element;
- wherein the first covering element is placed on the axial end region of the filter element which is opposite the second covering element;
- wherein through pressing of the covering element beads by means of the beading technique, the second covering element is connected with the filter element and the first covering element is connected with the filter element.
15. The method according to claim 14; wherein following the pressing of the covering element beads, a tube-shaped metal protective element configured as a grid-like perforated metal protective tube is arranged around the outer shell surface of the filter element facing away from the inner cavity of the filter insert for discharging the purified gas or for supplying the aerosol to be purified, or the outermost shell surface of the filter element furthest away from the inner cavity, and subsequently by the beading technique clamped on the outer shell surface of the filter element or on the outermost shell surface of the filter element

* * * * *